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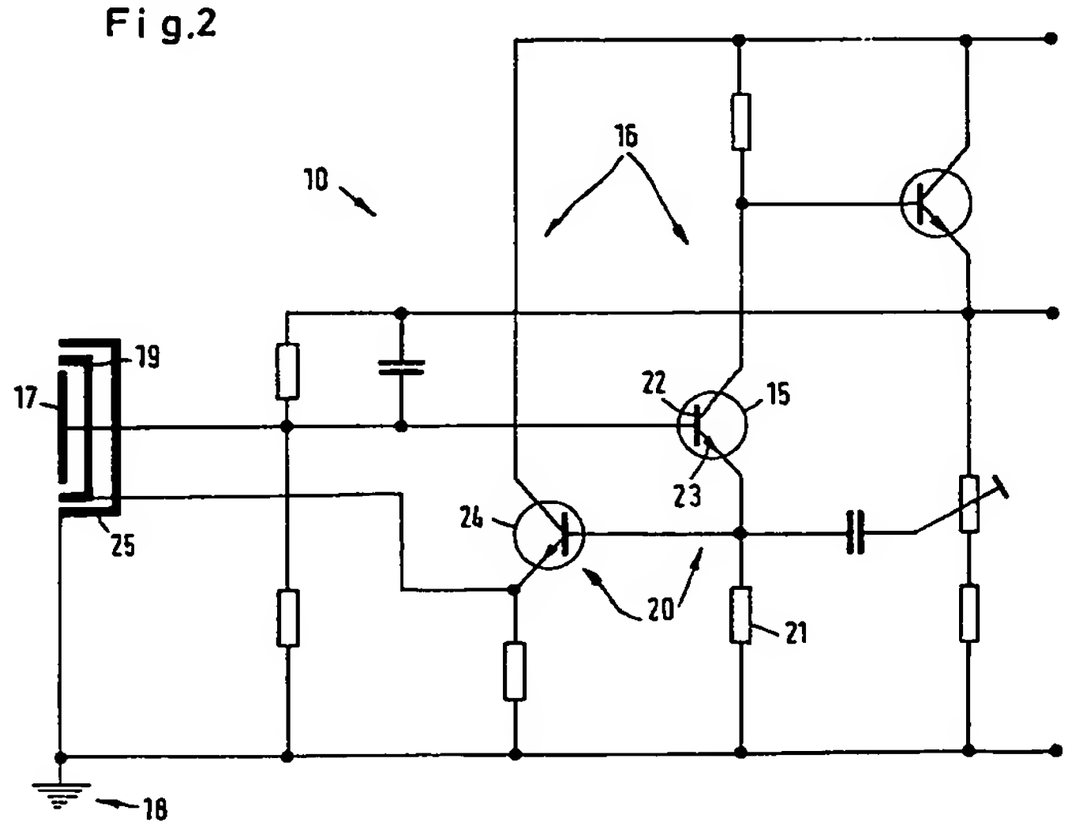
(54) Proximity switches

(57) The invention relates to contactless electronic switching devices in which a screening electrode protects a response electrode from undesired influences and at the same time does not impair the sensitivity of the switching device. The contactless electronic switching device includes an oscillator 10 susceptible to external influence, an electronic switch controllable by the oscillator and in which the oscillator features an amplifier transistor 15 and a resistive-capacitative feedback circuit 16, a response electrode 17 connected as part of the oscillator, an alteration of capacity between response electrode and earth 18 causing the oscillator 10 to commence or cease to oscillate, and at least one screening electrode 19 surrounding the response electrode 17, the transient alteration of potential difference between response electrode and screening electrode being approximately zero. This is achieved by coupling the electrode 17 to the emitter of amplifier 15 directly or *via* emitter follower 24.

Fig.2



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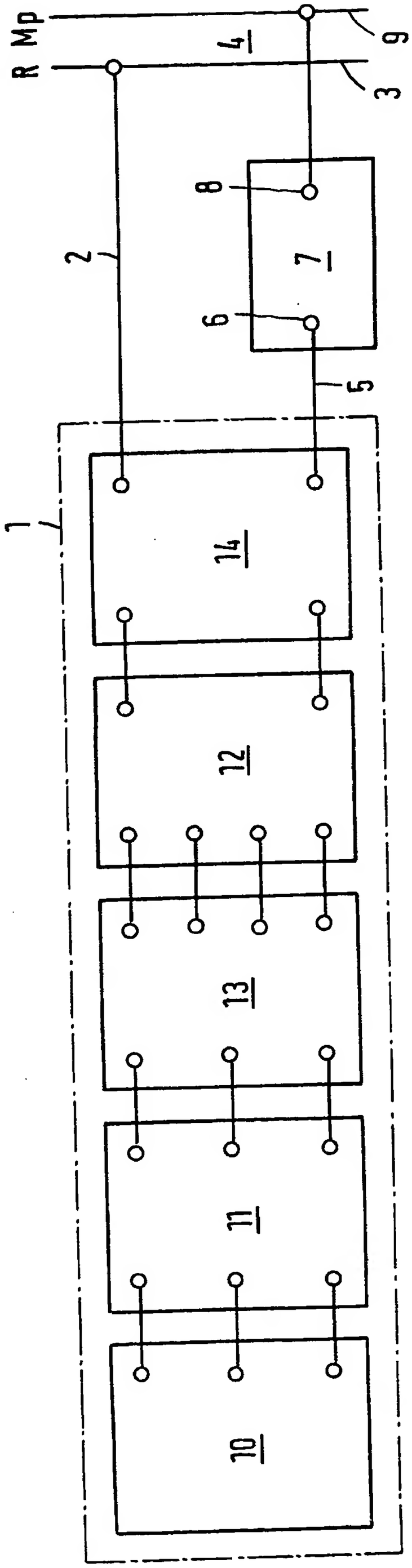

Fig.1

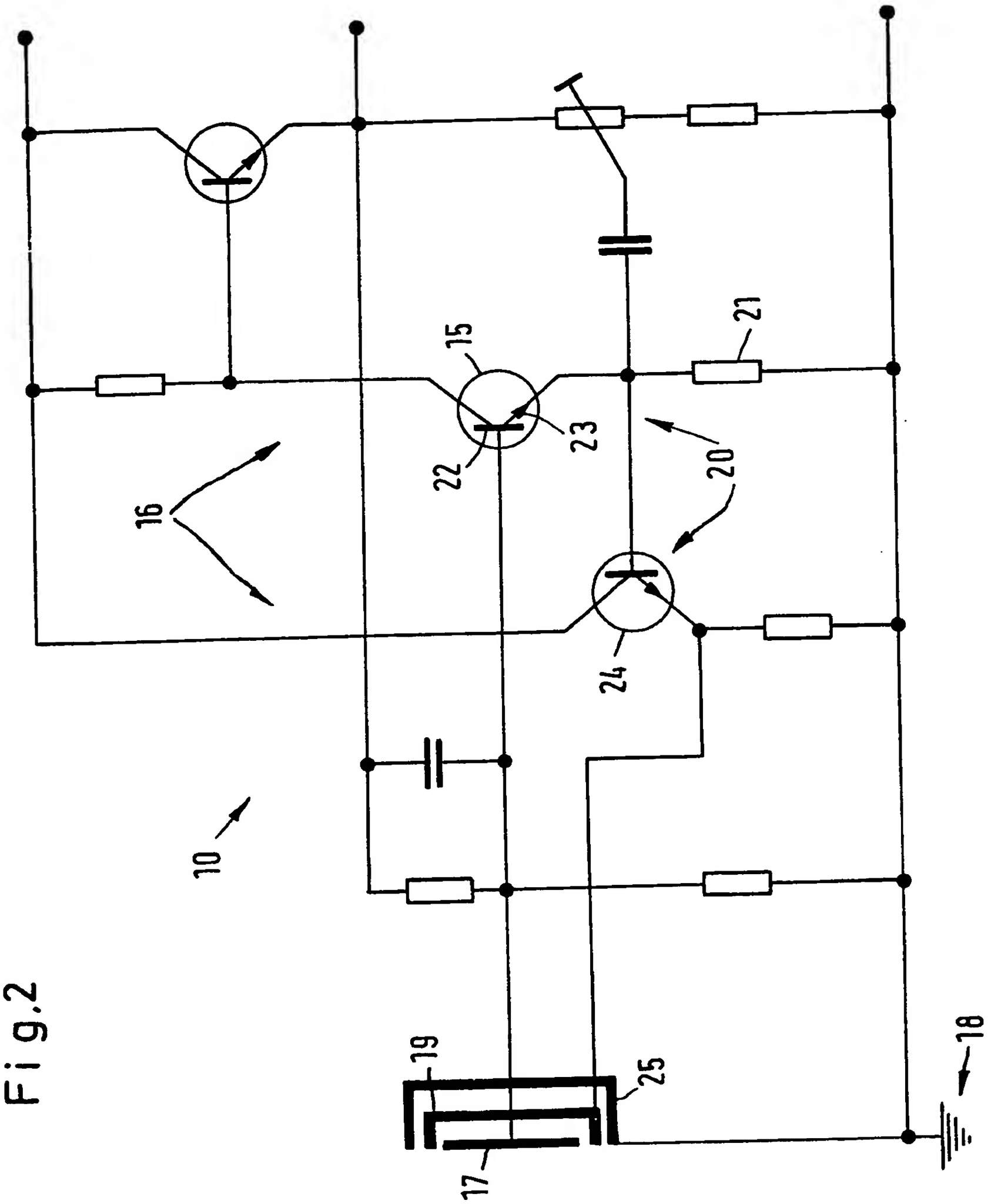

Fig.2

SPECIFICATION

"Contactless electronic switching device"

This invention relates to contactless electronic switching devices, consisting of an oscillator susceptible to external influence, an electronic switch, e.g. a transistor, a thyristor or a Triac, controllable by the oscillator, possibly via a switching amplifier or the like, and in certain cases a supply circuit for the production of a supply voltage for the oscillator and the switching amplifier, in which the oscillator is preferably constructed as an RC oscillator and has an amplifier transistor and a resistive-capacitative feedback circuit, in which a response electrode is part of the oscillator and an alteration of capacity between response electrode and earth causes the oscillator to commence or cease to oscillate, and in which at least one, preferably pot-shaped, screening electrode is provided surrounding the response electrode.

In a known form of construction of contactless electronic switching device the screening electrode is connected to earth potential. It is true that good screening of the response electrode is thereby achieved, and an alteration of capacity between earth and the side of the response electrode facing away from the screening electrode causes the oscillator to commence or cease to oscillate. However, the screening electrode connected to earth causes this capacitative device to be relatively insensitive. In fact in this form of construction of contactless electronic switching device a relatively large capacity exists between the response electrode and the screening electrode connected to earth which surrounds the response electrode in the shape of a pot. The capacity (between earth and the side of the response electrode facing away from the screening electrode) the alteration of which is intended to cause the oscillator to commence or cease to oscillate, lies in parallel with this relatively large capacity (between the screening electrode and the side of the response electrode facing towards the screening electrode). In consequence only relatively large alterations of capacity between earth and the side of the response electrode facing away from the screening electrode (hereinafter also called response capacity) result in the oscillator commencing or ceasing to oscillate.

In another known form of construction, the screening electrode is intended to be connected to the oscillator with its electrical field displaced 180° out of phase in reference to the electrical field of the response electrode, in a manner that damps down the onset of oscillation. This is intended to have the result that the switching device is to a large extent insensitive to alteration of capacity between the response electrode and the screening electrode, as this capacity would cause feed-back of the oscillator by which the onset of oscillation of the oscillator would be still further suppressed. The intention that the screening electrode should be connected to the oscillator with its electrical field displaced 180° out of phase with reference to the electrical field of the response electrode, in a manner that damps down the onset of oscillations, is based on a view of the circumstances that is not in accord with even the most elementary physics.

The object of the invention is to provide an improved contactless electronic switching device, in which the screening electrode can fulfil its purpose of protecting the response electrode from undesired influences in the most effective manner, and in which neither the sensitivity of the switching device to which the screening electrode is fitted is impaired, nor is it deleteriously affected in any other way.

According to the present invention, a contactless electronic switching device comprises an oscillator susceptible to external influence, an electronic switch controllable by the oscillator in which the oscillator features an amplifier transistor and a resistive capacitative feedback circuit, a response electrode being part of the oscillator and wherein an alteration of capacity between response electrode and earth causes the oscillator to commence or cease to oscillate, and at least one screening electrode provided surrounding the response electrode, the transient alteration of potential difference between response electrode and screening electrode being approximately zero.

The invention commences by considering that neither an alteration of capacity between response electrode and screening electrode nor an alteration of capacity between screening electrode and earth are to have an effect on the onset or cessation of oscillation. As alterations of capacity between response electrode and screening electrode, or alterations of capacity between screening electrode and earth cannot be absolutely excluded, then according to the invention such alterations of capacity are in fact prevented from causing the oscillator to commence or cease to oscillate by the transient alteration of potential difference between the response electrode and the screening electrode, i.e. du/dt, being maintained as close as possible to zero. If the transient alteration of potential difference between response electrode and screening electrode is in fact zero, then no displacement currents can flow between response electrode and screening electrode, thus alterations of capacity between response electrode and screening electrode or alterations of capacity between screening electrode and earth cannot influence the onset or cessation of oscillations by the oscillator of the switching device according to the invention.

Obviously, to take measures such that the transient alteration of potential difference between the response electrode and the screening electrode is as nearly as possible zero, may not be carried out by connecting the screening electrode to the response electrode through a resistance of relatively high resistance value. Nevertheless, to take measures such that the transient alteration of potential difference between the response electrode and the screening electrode is as nearly as possible zero can be carried out by connecting the screening electrode to the response electrode via a follower amplifier. The follower amplifier must be so designed that on one hand the potential of the screening electrode always "follows" the potential of the response elec-

trode (in value and phase) and on the other hand the screening electrode is to a considerable degree decoupled by resistance from the response electrode. A "loading" of the screening electrode, e.g. by alteration of capacity between screening electrode and earth, may not be allowed to have any effect, in practice, on the response electrode. This stipulation requires the above-described follower amplifier of the contactless electronic switching device according to the invention to be constructed without feedback and preferably with a relatively high input resistance and a relatively low output resistance.

If in the contactless electronic switching device according to the invention, the oscillator has an amplifier transistor driven in the emitter circuit and an emitter resistance, then according to a further feature of the invention, the response electrode can, as is in itself known, be connected to the base of the amplifier transistor and the screening electrode can be connected to the emitter of the amplifier transistor, so that the amplifier transistor of the oscillator can assume the function of the follower amplifier at the same time. If a field-effect transistor is provided as amplifier transistor then the above-explained requirement of freedom from feedback, large input resistance and small output resistance is particularly well met. If a field-effect transistor is provided as amplifier transistor, then also the screening electrode can equally well be connected, via a second amplifier transistor driven as an emitter-follower, to the emitter of the first amplifier transistor - so that the screening electrode is even more effectively decoupled from the response electrode.

Finally according to a further feature of the invention, as is in itself known, a second screening electrode can be provided and connected to earth potential. This second screening electrode can surround the first screening electrode in the form of a pot, it can however in addition surround the other electrical components of the switching device, at least partially, preferably in the shape of a pot. In the contactless electronic switching device according to the invention, the combined effects of the response electrode, the first screening electrode and the second screening electrode result in that on one hand the response electrode receives maximum protection from undesired influences and on the other hand the response sensitivity is not reduced, because the capacity between the two screening electrodes is not in parallel with the capacity between the response electrode and earth, and that finally the screening of the first screening electrode by the second screening electrode reinforces the effect that otherwise possible alterations of capacity between the first screening electrode and earth remain without effect. Whether the second screening electrode surrounds the remaining electrical components of the switching device partially or completely, external influences are prevented from operating in the electronic switching device working without contact according to the invention.

One embodiment of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a block circuit diagram of contactless electronic switching device according to the invention; and

Figure 2 shows the oscillator of the electronic switching device according to Figure 1.

The electronic switching device 1 represented in Figure 1 works without contact, i.e. it responds to an approaching response body which is not shown in Figure 1 and is connectable by one external lead 2 to one pole 3 of a power supply 4 and only by one further external lead 5 to a connector 6 of a load 7, in which the other connector 8 of the load 7 is connected to the other pole 9 of the power supply 4. In other words the electronic switching device 1 represented is connectable by a total of only two external leads 2, 5 on one side to the power supply 4 and on the other side to the load 7.

In basic construction, the electronic, i.e. contactless switching device represented in Figure 1 consists of an oscillator 10 which can be influenced externally, namely by the response body, a controllable electronic switch 12, e.g. a transistor, a thyristor or a Triac, controllable by the oscillator 10 view a switching amplifier 11 and a supply circuit 13 for the production of the supply voltage for the oscillator 10 and the switching amplifier 11. There is also an additional rectifier bridge 14 provided on the input side, as the power supply 4 provides alternating current.

As Figure 2 shows, the oscillator 10 is constructed as an RC osillator, i.e. an oscillator consisting of an amplifier transistor 15 with a resistive-capacitative feedback circuit 16. A response electrode 17 is also part of oscillator 10. Alteration of capacity between response electrode 17 and earth 18 causes oscillator 10 to commence or cease to oscillate. Finally a pot-shaped screening electrode 19 is provided, surrounding response electrode 17.

According to the invention care must be taken to ensure that the transient alteration of potential difference between response electrode 17 and screening electrode 19 is approximately zero. For this purpose the screening electrode 19 is connected via a follower amplifier 20 to response electrode 17. The follower amplifier 20 is constructed without feedback and has a relatively high input resistance and a relatively low output reistance.

The oscillator 10 has an amplifier transistor 15 driven in the emitter circuit and an emitter resistance 21, the response electrode 17 is connected to the base 22 and screening electrode 19 to the emitter 23 of amplifier transistor 15 (A "normal" non-transistor is provided as amplifier transistor 15, but a field-effect transistor could be used instead). In particular, screening electrode 19 is connected to emitter 23 of the first amplifier transistor 15 via a second amplifier transistor 24 driven as an emitter-follower. Thus as shown the follower amplifier 20 consists of amplifier transistor 15 (part of oscillator 10) and the second, emitter follower-driven amplifier transistor 24.

Figure 2 shows a preferred form of construction of contactless electronic switching device 1, in that a second screening electrode 25 is provided and is connected to earth potential (potential of earth 18). The second screening electrode 25 surrounds the first screening electrode 19 in the shape of a pot, just as the first screening electrode 19 surrounds the

response electrode 17 in the shape of a pot. (It is not shown that the second screening electrode 25 can also preferably surround, at least partially, in the shape of a pot, the other electrical components of switching device 1).

CLAIMS

1. A contactless electronic switching device comprising an oscillator susceptible to external influence, an electronic switch, controllable by the oscillator, in which the oscillator features an amplifier transistor and a resistive-capacitative feedback circuit, a response electrode being part of the oscillator and wherein an alteration of capacity between response electrode and earth causes the oscillator to commence or cease to oscillate, and at least one, screening electrode provided surrounding the response electrode, the transient alteration of potential difference between response electrode and screening electrode being approximately zero.

2. An electronic switching device according to Claim 1, wherein the screening electrode is connected to the response electrode via a follower amplifier.

3. An electronic switching device according to Claim 2, wherein the follower amplifier is constructed without feedback and preferably has a relatively high input resistance and a relatively low output resistance.

4. An electronic switching device according to Claim 3, wherein the oscillator has an amplifier transistor driven in the emitter circuit, the response electrode as is in itself known, being connected to the base of amplifier transistor and the screening electrode being connected to the emitter of the amplifier transistor

5. An electronic siwtching device according to Claim 4, wherein a field-effect transistor is provided as amplifier transistor.

6. An electronic switching device according to Claim 4 or Claim 5, wherein the screening electrode is connected to the emitter of the first amplifier transistor via a second amplifier transistor driven as an emitter-follower.

7. An electronic switching device according to any one of Claims 1 to 6, wherein as is in itself known, a second screening electrode is provided and the second screening electrode is connected to earth potential.

8. An electronic switching device according to Claim 7, wherein the second screening electrode surrounds the first screening electrod ein the shape of a pot.

9. An electronic swtiching device according to Claim 7 or Claim 8, wherein the second screening electrode preferably surrounds, at least partially, in the shape of a pot, the other electrical components of the switching device.

10. A contactless electronic switching device comprising an oscillator susceptible to external influence, an electronic switch, e.g. a transistor, a thyristor or a Triac, controllable by the oscillator possibly via a switching amplifier or the like, and in certain cases a supply circuit for the production of a supply voltage for the oscillator and for the switching amplifier, in which the oscillator is preferably constructed as an RC oscillator and features an amplifier transistor and a resistive-capacitative feedback circuit, a response electrode being part of the oscillator and wherein an alteration of capacity between the response electrode and earth causes the oscillator to commence or cease to oscillate, and at least one preferably pot-shaped screening electrode being provided surrounding the response electrode, the transient alteration of potential difference between the response electrode and the screening electrode being approximately zero.

11. A contactless electronic switching device substantially as hereinbefore described with reference to the accompanying drawings.

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